

2

OBSERVATIONS
ON
THE MEDICAL EFFECTS
OF
COMPRESSION
BY
THE TOURNIQUET.

By GEORGE KELLIE,
SURGEON IN HIS MAJESTY'S NAVY,
AND MEMBER OF THE AMERICAN PHYSICAL SOCIETY
OF EDINBURGH.

EDINBURGH:

PRINTED FOR G. MUDIE AND SON, SOUTH BRIDGE;
AND J. JOHNSON, LONDON.

1797.



P R E F A C E.

I TAKE the liberty of presenting to the Public the following Letters from a son, whose particular attention to every thing which respects his profession has at all times given me great satisfaction.

Soon after I received them, they were put into the hands of some medical friends, of whose judgement I entertain a high opinion. The approbation which they were pleased to bestow on the Letters led me to think, that some benefit might accrue from

a their

their being submitted to public inspection. Accordingly, at the desire of my friend Dr Duncan, the first of them was published in the Edinburgh Medical Commentaries for 1794. But the second Letter, which I have only lately received, and which contains numerous and important observations, is necessarily extended to a greater length than is accommodated to the limits of his Periodical Work. By his advice, therefore, as well as by that of several other friends, I have been induced to make it the subject of a separate publication. And the first Letter, which may be considered as in some degree a necessary introduction, is also reprinted.

If it shall be the opinion of candid readers, after bestowing an attentive perusal on these Letters, that they do no discredit to the genius or judgement of the writer, and that the facts which they contain may in some degree both extend the knowledge of the animal economy, and improve the practice of medicine, the publication of them will afford some satisfaction to

Their most obedient Servant,

GEORGE KELLIE,

SURGEON, LEITH.

Leith, 20th January }
1797.

OBSERVATIONS

OBSERVATIONS

ON

THE MEDICAL EFFECTS

OF

COMPRESSION BY THE TOURNIQUET.

LETTER I.

*His Majesty's Ship Iris,
May 21. 1794.*

AGREEABLE to a promise which I made you in my last letter, I propose taking advantage of the Leith tender, now here, to send you some observations, I
A have

have made, on the effects of tourniquets, in stopping the cold fit of intermittents, and thereby shortening, and rendering more mild, the whole paroxysm.

I received the first hint on this subject, when in Holland last year, from the pilot we had on board the Expedition. We were, in the month of March, lying off Williamstadt, at that time besieged by the French, when several of our people were seized with agues. They were, however, mild, and easily subdued by bark and a morning-glass of gin, which the Dutch themselves take very liberally, and perhaps safely, as a preservative from the baneful miasmata of their country. In speaking of these complaints, our pilot told me, that he had once suffered very severely from a quartan, with which he was afflicted for many months. The cold fit, he said, was particularly severe ; and he always suffered more from it than from the other periods

periods of the paroxysm ; and that an old woman had at length furnished him with a most effectual means of putting an entire stop to it, and that too without the assistance of any medicine whatever. The secret was simply to tie one *garter* round the *right arm*, and another round the *left thigh*, tight enough to obstruct the circulation below. And this he had done very frequently with certain success. I was disposed to doubt the account, or, at least, to suppose some mistake or fallacy in it. A few days after, however, I had an opportunity of making some experiments, which proved beyond doubt that the account was true.

JOHN HUMPHRIES, one of the seamen, was seized with a very regular tertian ague, in which the cold fit and shaking were pretty severe, and I was induced to make trial of this strange remedy upon him. I therefore desired I might be called the moment he perceived the approach of the next paroxysm.

A

On

On the 20th of March, about ten in the morning, on the approach of the cold fit, I was accordingly called, and found the usual symptoms of the first stage of an ague completely formed; he was shaking very violently, and complained of very severe pain across the loins. I had prepared myself with two tourniquets, and now applied one to the right arm, and the other to his opposite thigh, at the place where it is commonly applied in amputations above the knee. I thus stopped the circulation of these extremities below the tourniquets, and found to my surprise and pleasure, that in two minutes thereafter, the shaking, and other symptoms of the cold stage, entirely ceased; a mild hot stage was immediately induced, and the man found himself quite relieved; for the severe pain across the loins had also vanished.

I kept the tourniquets applied fifteen minutes,

nutes, and then removed them entirely. The cold symptoms did not return.

About eleven in the forenoon of the 22d instant, he was again attacked. When I saw him, he was shaking very violently, and complained of headach, and pain of the loins. Before screwing the tourniquets, I counted his pulse ; it was small and hard, beating just 100 times in sixty seconds. I now, as before, stopped the circulation in both extremities. I kept a watch with a stop and second hand before me, and found that, in three minutes, from the obstruction of the circulation in the extremities, the cold stage entirely ceased, the headach was easier, and pain of the loins entirely gone. I kept the tourniquets on ten minutes, and now counted the pulse, which I found soft and full, beating 120 in a minute. He was thirsty ; but had no other complaint. Every symptom of the hot stage was

uncommonly mild, and the whole paroxysm very short.

On the morning of the 24th, I placed the tourniquets, as formerly, on the extremities, some time before he expected the paroxysm, and directed them to be screwed the instant he perceived the approach of his ague. About half past ten, he perceived the symptoms which precede the shaking, viz. lassitude, and the pain of his back; and therefore, agreeable to my directions, screwed the tourniquets. The cold stage was entirely prevented. The tourniquets were kept on five minutes only. When they were removed, his pulse beat 112 in a minute. He was hot and thirsty, and complained of slight headach. These symptoms of pyrexia continued three hours, and terminated by a copious perspiration.

In all the intermissions, he had regularly taken

ken the Peruvian bark ; and this was the last paroxysm with which he was seized.

From this time till the month of July following, I had no opportunity of making farther trials of this kind. When lying in Carrick roads, Falmouth, in his Majesty's frigate the Sphynx, JOHN GREY, one of the quarter-masters, was seized with aguish symptoms. Early in the morning of the 21st July, he was attacked with shiverings, and cold shaking, succeeded by heat, headach, and pain of the stomach. I saw him about ten in the morning, and ordered him an emetic. It operated well. In the evening, he perspired freely, and was afterwards quite easy. Next day he complained of headach, and his pulse was somewhat full, and accelerated. He was ordered an ounce of a common antimonial julep every hour, which I generally keep prepared as an universal antidote for those slight febrile complaints so frequent amongst seamen,

from obstructed perspiration. In the evening he was relieved by sweating.

On the 23d instant he had a very regular paroxysm of the ague, beginning with lassitude and shaking, succeeded by heat, thirst, head-ach, and fever, and abating with a copious perspiration.

Next day he was well; and, from eight in the morning till three in the afternoon, took every hour half a drachm of bark.

Expecting he would be seized on the 25th instant, in the same manner as on the 23d, I desired I might be acquainted the moment he perceived the cold and shaking come on.

He was accordingly attacked about eleven in the morning; and when I was called, I found him agitated by very severe succussions. I immediately applied the tourniquets, one
to

to the arm, the other to the opposite thigh. In three minutes from their application, the shaking, and other symptoms of the cold stage of ague, entirely ceased; the hot fit came on, and ran its usual course. The day following he was well, and took the Peruvian bark.

On the 27th, although I expected a paroxysm, I was under the necessity of being ashore, and therefore desired Mr Macqueen, the surgeon's mate, if Grey should be seized, to apply the tourniquets as I had done, and to note the result. At eleven he was attacked with the cold fit. The tourniquets were applied as directed; and, as usual, put an end to that stage of the disorder in two minutes.

For three days after this, he continued to take the bark, and never had another fit. As cases of intermittents seldom occur in ship-practice in those seas, and wishing to have as many trials of the tourniquets as I could collect, I
 have

have begged the favour of several practitioners to try them ; but from the wandering unsettled nature of my situation, I have never been long enough in one place to know the results. On our arrival, however, in this harbour, I found there were some cases of ague on board his Majesty's hospital-ship, the Union ; I therefore begged the favour of Mr Veitch, surgeon's first mate of the hospital, to repeat the trials I had already made. He was so obliging as to do so repeatedly, in several cases, with considerable care ; and informed me, " that in every case in which he applied the tourniquets as I directed, the cold stage was put a stop to, within three minutes after their application ; and that, although the hot stage was never entirely prevented, yet he always observed, that the whole paroxysm was much shorter in duration, and every symptom of the hot stage milder."

Upon the whole, therefore, from the few
trials

trials I have had opportunity of making, it appears confirmed,

1st, That at any time *during* the *cold fit* of an intermittent, if the tourniquets be so applied as to obstruct the circulation in two of the extremities, in three minutes thereafter the hot stage will be induced.

2^{dly}, That if the tourniquets be applied *previous* to the accession of the paroxysm, the cold stage will be entirely prevented.

3^{dly}, That where the cold stage of an ague is either thus shortened, or altogether prevented, the following hot stage is rendered both milder and shorter in its duration.

How far these results of a few experiments may be found applicable to the practice of medicine in these disorders, time and future observations must and can only determine. This much, however, is certain, that the indications for which they are used, are already laid down by our best physicians; for, to put

a stop to the paroxysm in its beginning, has long been esteemed a great object ; and with this view, spiritous liquors, hot tinctures, and spices, opiates and emetics, are frequently, though not always successfully, employed.

It is probable, that the tourniquets act in the same way as these, though more certainly, viz. by increasing the powers of the sanguiferous system, during the state of atony of the extreme vessels.

Dr Cullen, you know, supposes, that in every paroxysm of fever, there exists an atony and spasm in the extreme vessels of the system, and that the hot stage itself is the effort of the *vis medicatrix naturæ*, to overcome the spasm, and restore the tone of these vessels. Now, an increase of the velocity and momentum of the blood in the circulatory system, is the certain and invariable effect of obstructing the circulation in any part of it, as I have found from repeatedly applying the tourniquets on

my own person, in the same manner as I had employed them on those affected with ague. I have thus determined their effects on the healthy body, and find that they occasion,

1st, Great increase in the velocity of the circulation, as judged from the pulsation of the heart and arteries.

2dly, Increase of heat, and flushing of the face.

3dly, Anxiety, and more frequent respiration.

4thly, The tourniquets being kept on more than six minutes, induce a tendency to syncope.

5thly, The tourniquets being removed, and the circulation restored, the velocity of the circulation soon falls to its natural standard, and frequently considerably below that.

I shall give you, as an example, an experiment which I made only last night, when going to bed.

PULSE.

PULSE.	
70—Small, & rather hard,	Before the application of the tourniquet.
90—Full, & rebounding,	The circulation being obstructed in two extremities for four minutes—heat and anxiety—I removed the tourniquets.
84— Full & soft,	The tourniquets being removed.
68, and soft,	15 minutes after the tourniquets were removed.
60, and soft,	25 minutes after the tourniquets had been removed.
60, and soft,	An hour after the tourniquets had been removed.
60—Small, hard,	Next morning before breakfast.
68,	Two hours after breakfast.

From this experiment you see, that in five minutes from the obstruction of the circulation, my pulse had increased in velocity by 20 beats in a minute ; and that an hour after their removal, my pulse fell ten below what it was

was previous to their application. The *tour-niquet*, therefore, may be classed along with those remedies which operate by increasing the momentum and velocity of the circulating fluids, and therefore assisting the efforts of nature in putting an end to the paroxysm. And of all remedies of this kind, I am convinced it will be found the most powerful.

If any opportunities should occur in your practice, I wish you to give them a trial, and communicate to me the result. In the meantime, I commit the above observations entirely to your hands, giving you every power over them which you may think proper to use.

LETTER

L E T T E R II.

*His Majesty's Ship Leopard,
Sheerness, Sept. 8. 1796.*

TWO years have now elapsed, since I first communicated to you the observations I had then made on a very curious fact. I allude to the effects of compression of the arteries of the extremities, in cases of intermittent fever.

These having been put into the hands of some medical friends at Edinburgh; and having excited some attention, were published in the Medical Commentaries of Dr Duncan, for the year 1794.

Besides the novelty of the fact, the certainty of so speedily putting an end to the cold stage, and of inducing, and rendering shorter and milder, the subsequent hot stage of an intermittent

termittent paroxysm, appeared to me no small acquisition to our art; and I hence hoped, that the curiosity, which had been raised, would not have proved barren, and that some one, whose ability and opportunities of observation far exceeded mine, would have made new experiments, and prosecuted the subject. I cannot avoid thinking, that a person so qualified would have reaped a bountiful harvest. As no one, however, appears to have been yet excited to this attempt, I trust I shall be excused for again claiming your attention, and that of your friends, to what further observations I have made on this interesting subject.

S E C T. I.

I. IF in a healthy person we obstruct the circulation in two or more extremities, by the tourniquet, the pulse at first increases in frequency, and becomes at the same time fuller

B

and

and stronger ; but in some time after, the frequency diminishes, so as even to be less than before the compressions were made. Some increase of heat is soon discovered, especially in the face and breast ; anxiety, and a sense of fullness about the præcordia, are perceived, which gradually increase, till the person becomes faint, or vertiginous. The countenance appears turgid, and in some experiments, the angular, temporal, and jugular veins, were observed fuller, and more distended than they were before the compressions were made, or after the tourniquets were removed. If the compressions be continued for twenty minutes, or half an hour, the vision becomes somewhat confused ; objects appear double, or clouded, and small black spectra are seen floating past the eyes ; drops of sweat now stand on the face, neck, and breast ; and the increasing vertigo, sickness, and tendency to deliquium, demand the removal of the tourniquets.

On

On restoring the circulation, these symptoms almost immediately vanish; a coldness about the præcordia, and chillness of the whole body, is then perceived, attended sometimes with shudderings, and yawning; the blood flows with a painful heat, through the vessels which had been compressed, the whole limb is suffused with a glow, and this is succeeded by a sensation of prickling; the pulse continues slow, and generally becomes slower than it was before the compressions were removed, beating at the same time full and soft,

EXPERIMENT.

ON the 15th of January last, I made choice of a healthy young man, from the ship's company, named John Pinchin, and at fifteen minutes after ten in the morning, I applied a tourniquet on his right-arm, and compressed

the brachial artery. His pulse at this time was full, strong, and somewhat hard, and beat just 84 in the minute.

Twenty-five minutes after ten, pulse 78, but no other alteration perceived.

Thirty minutes after ten, I compressed the femoral artery of the same side.

Thirty-five minutes after ten, he complained of increased heat, anxiety, and fullness about the breast; and he inspired deeply, pulse 60, very full, and soft.

Forty minutes after ten, his anxiety was greatly increased; complained of vertigo, and tendency to deliquium; and his body was covered with sweat, pulse 60. The tourniquets were now removed from both the arm and leg, and the vertigo and faintness were instantly relieved.

At

At eleven o'clock, pulse continued at 64, but is not so full as before.

The trials, which I have made on my own person, and on some others, agree with these results in most particulars, excepting that the frequency of my pulse is somewhat increased during the continuance of the compression.

2. If the circulation be obstructed in one arm, for fifteen minutes or half an hour, the pulse, after the removal of the compression, will be found fuller and stronger in this than in the other arm.

3. If the tourniquets be properly applied, so as instantly and completely to compress the artery, the veins of the compressed limb do not swell, or appear turgid, and the limb itself feels soft, and flaccid, rather than hard. But if the artery be not completely compressed, or if any time be lost in screwing the tourniquet, the veins are first compressed, and allowed to

fill before the communication between the heart and arteries is destroyed, and hence they appear turgid with blood ; and the limb feels hard, and painful from distention.

4. When the circulation is thus completely obstructed in an extremity, if a vein be opened below the tourniquet, the blood will flow, and the compressed vessels may be thus entirely drained of their contents.

5. If, after the compression has been continued some time, a vein be opened below the tourniquet, it will discharge freely enough, and by pressing and rubbing the arm, between two and three ounces of blood, of an uncommonly *dark* colour, may be procured. When the blood-vessels have thus been emptied of their contents, if we remove the compression from the artery, and continue it on the vein, the blood will again flow freely from the orifice, but very different in appearance from that which was procured while the circulation was obstructed, being now thinner and more florid.

If

If an equal quantity of this be received into a separate, but similar vessel, to that which contains the former, and both be set aside under similar circumstances, to coagulate, the following differences will be observed. That, which was drawn from the vein while the arteries were compressed, coagulates sooner than the other, and never shews any buffy coat, although in that, which flowed from the same orifice, after the restoration of the circulation, it may be very conspicuous. The same difference of colour which was observed while they flowed from the vein, and remained fluid, continues after coagulation, for the coagulum of the former is dark and grumous, of the latter lighter and more florid. Sometimes, however, this difference of colour is not so remarkable. It is generally more conspicuous, the longer the compression has been continued, and the freer the blood is of the inflammatory crust, or buffy coat. Where this is abundant, I have always found the difference of colour very in-

considerable ; a circumstance, which at first puzzled me, but which, I now think, may be thus explained. The blood drawn from the vein when the circulation is obstructed in the artery, very soon coagulates, and, as I have just observed, never shows any inflammatory crust : its coagulum, therefore, is uniformly firm, and the red globules are more diffused, and farther separated from each other, than they are where the buffy coat is present ; for in this case the blood is much longer in coagulating, as has been observed by Hewson, the red globules sink downwards by their weight, and the coagulable lymph remains pure, and colourless on the surface ; hence the red globules are more concentrated, and appear consequently darker, than if they had been diffused through, and diluted by that portion of the coagulable lymph, which forms the buffy coat. This account receives confirmation from observing, that the coagulum, which is covered with a buffy coat, is always less firm,

firm, and darker coloured than usual, and that the lower parts of the coagulum are darker, and less firm than the upper and middle parts.

EXPERIMENT I.

GEORGE MORTON laboured under an acute rheumatism, the pains were particularly severe in the right-wrist, and left-knee, and both were considerably swelled. The circulation of the affected arm having been obstructed fifteen minutes, the pain entirely left his wrist, but the swelling continued.

It then occurred to me, for the first time, that if, while the arteries were compressed, I opened a vein below the tourniquet, I should be able to empty the whole of the vessels, and that the swelling would consequently subside. I now, therefore, opened a vein on the back of the hand, and procured about three ounces
of

of blood, so strikingly dark in colour, that it was impossible to avoid remarking it. I set it therefore aside, that I might compare it with what I now resolved to procure from the same orifice, when the circulation should be restored. The swelling entirely subsided, and the compression was in a few minutes after removed; the blood again flowed from the vein, but of a light florid colour, and thinner appearance. Three ounces of this were received into a vessel similar to that containing the former, and on examination, after coagulation, the difference of colour was still more conspicuous.

On comparing the coagula some hours after, the one appeared very black, the other very florid; and on dividing them with a knife, the same difference was observable. In other respects they did not differ, neither shewed any buffy coat; and the proportion of crassamentum

crassamentum and serum was the same in both.

EXPERIMENT II.

ZACHARIAH STEVENS had a slight fever, with severe headach, for which compression by the tourniquet was successfully used. The circulation having been suppressed for a quarter of an hour in the arm, I opened the median vein, and procured about two ounces of blood, which was received into a wine-glass. I then removed the compression, and drew off into another glass, two ounces more. The difference of colour was sufficiently conspicuous, as they flowed from the vein, but very little after coagulation. The latter, however, was covered with a slightly buffy coat; the former had none.

EXPERIMENT

EXPERIMENT III.

IN a similar case, little difference of colour could be perceived after coagulation, although this was sufficiently obvious, while the blood remained fluid ; and in this case too, the blood which was procured, while the circulation was free, was covered with a very thick inflammatory crust, and remained longer fluid than I had ever before observed.

EXPERIMENT IV.

SAMUEL YATES. When the circulation of the arm had been obstructed twenty minutes, I opened the cephalic vein, and procured about half an ounce of blood only. I then restored the circulation, and drew off from the same orifice, into another vessel, four ounces of blood. I now stopped the opening of the
vein

vein with my finger, and again compressed the artery with the tourniquet, but in such a gradual manner, as to allow the veins to fill before the compression was complete. When the compression had thus been continued five minutes, I removed my finger from the orifice of the vein, and by pressing the arm from below upwards, procured about three ounces of very black blood. These three different quantities of blood, which were received into separate, but similar tin-vessels, were examined eight hours afterwards. The coagulum of the blood which was drawn, when the circulation was free, was more florid, and of a much lighter colour, than the other two coagula, which were dark and grumous. None of these had any inflammatory crusts.

The darker colour observed in the blood, which has been detained for some time by compression in the veins and capillaries, will receive some explanation, by observing, that the same difference

ference of colour which we find between the blood flowing from the vein, when the circulation is free; and when it has been for some time obstructed, is also discovered between arterial and venal blood, and between the contents of the left and right ventricle of the heart. Now, as it is certain the blood acquires its floridity during its passage through the lungs, and as experiments have shown, that this is effected by the combination of the oxygene of the atmosphere, with the circulating mass, which it again parts with, in the course of its circulation through the other parts of the body, while at the same time it acquires a darker and more grumous colour, it would appear, that the blood, when it is longer detained in the veins and capillaries by compression, suffers a more complete disoxygenation, and accordingly assumes a darker colour.

The dark livid face of strangulated people,
of

of asthmatics, of patients after a violent fit of coughing, of children after a violent fit of laughing or crying, is probably owing to the same cause.

May not the slowness of the pulse, which follows the removal of the compressions, be partly owing to the return of this difoxygenated, and therefore less stimulating, blood to the heart?

If the blood may thus be further deprived of its oxygene, would compression of two or more extremities for half an hour, repeated two or three times a-day, be of any use in pthisis pulmonalis, a disease in which it is now supposed the circulating mass is hyper-oxygenated?

At any rate, might not the periodical exacerbations of hectic fever be thus prevented?

S E C T. II.

THESE observations on the general effects of compression, it seemed necessary to premise, as they all take place, more or less, under whatever circumstances such compressions are made. I shall now proceed to give you an account of the effects of compression in some diseases.

I. In intermittents. If the two iliacs, or one iliac and one subclavian, be compressed about the time of an expected paroxysm, and the compression continued till the usual period of attack be fully elapsed, the fit will be prevented, or postponed. If the cold stage have taken place, before the compressions are made, in three, four, or five minutes, the sensation of cold, the rigours and succussions will cease; the pulse, from being frequent, small, and weak,

weak becomes fuller and stronger, and after some time less frequent ; the pain of the loins, and afterwards the headach, goes off ; the nausea, anxiety, and thirst, are relieved ; and the hot fit is thus induced with milder symptoms, and of a shorter duration, than any former one. If the compression be continued for some time after these changes have been induced, the cold fit will not return. The compression ought generally to be continued ten or fifteen minutes, for the symptoms of the hot stage are thus moderated ; but it ought seldom to be continued much longer, for I have observed, where this has been done, the pulse, which had become fuller, stronger, and slower, has again been rendered smaller, and more frequent ; and when the tourniquets were removed, the rigors and succussions returned.

C A S E I.

SAMUEL YATES has been for some days past regularly attacked every morning, between eight and nine o'clock, with severe headach, which continues till noon. When he is attacked, he complains of cold, and rigors, and, in the course of an hour, grows hot, and thirsty. The paroxysm is terminated about noon, by sweating, and he finds himself tolerably well for the remaining part of the day. Has taken an emetic, without relief.

January 7. 1796.—Paroxysm went off yesterday, about two P. M. and returned this morning, at half past eight. At a quarter after nine, he still complains of coldness, and he is affected with some tremblings; complains also of thirst; pulse 80, and very small. I now applied a tourniquet to the left thigh, and
another

another to the right arm. In three minutes from their application, the headach ceased; he grew warm, and the tremors went off. The compression was continued fifteen minutes; the pulse was but little altered, either in strength or frequency. On removing the tourniquet from the arm, the pulse was observed much stronger and fuller in that wrist, than in the other, which had not been compressed. On removing the tourniquet from the thigh, the pulse fell suddenly to 70, and was stronger and softer than before.

January 8.—Had no return of headach, after its removal yesterday.

At half past seven A. M. continues free from complaint, pulse 86, and small. The tourniquets were applied as yesterday:

At eight o'clock, pulse 78; no other change.

Ten minutes after eight, heat greatly increased, complains of anxiety, pulse 70, full and soft.

Twenty minutes after eight, heat and anxiety very great, pulse now 80, and smaller than at last trial. The compressions having now been continued fifty minutes, and the period of the expected paroxysm elapsed, the tourniquets were removed.

Twenty-five minutes after eight, pulse only 54, full and soft, and stronger in the arm which had been compressed, than in the other ; anxiety and faintness gone off.

Thirty-five minutes after eight, pulse 60, of the same strength in both arms.

January 9.—Had no attack yesterday. It is now eleven o'clock, and he has as yet had

no

no return of headach, feels himself quite well, and returned to his duty.

C A S E II.

WILLIAM WISTLE.

January 12. 1796.—Complains of very acute pain in the left-side of the head; his features are very much collapsed; he is cold, and shakes violently; pulse quick, and very small. Sumat pulv. ipecac. ʒi.

13. Vomit operated well; he slept tolerably, and perspired during the night; says he finds himself much better this morning, but he still complains of headach. He now informs me, that he has just left the Marine Hospital at Chatham, and when he came on board the *Iris* a few days ago, supposed himself cured of the ague. That since joining the

ship, he has, however, been daily seized with the headach of which he now complains. The most severe attack is generally in the evening, and is ushered in by coldness, rigors, and succussions. Belly costive. Sumat bol. ex rhæo, et calomel.

At six P. M. has just been seized with a very severe attack of hemicrania ; his countenance is pale and squalid, nose, ears, and fingers feel cold when touched, and he is struck with repeated succussions, and constant tremors. Pulse so feeble and small, that it cannot be distinctly felt at the wrist, but counted at the flexure of the arm 100.

Ten minutes after six, I compressed the right iliac artery.

Sixteen minutes after six, tremors have ceased ; pulse fuller and softer, still 100 ; feels himself hotter ; headach nowise relieved.

Twenty

Twenty minutes after six, I compressed the left subclavian.

Thirty minutes after six, pulse very full and soft at the wrist; heat and thirst increased; headach considerably easier.

Thirty-seven minutes after six, headach quite gone off. The tourniquets being uneasy, were now removed from the left to the right arm, and from the right to the left thigh.

Forty minutes after six, coldness and shakings have returned; pulse 110, small and feeble. The tourniquets were instantly removed, and the tremors quickly ceased; the pulse became full and soft, and fell to 96.

Fifty minutes after six, no complaint, excepting thirst; pulse 94, and of natural strength.

Seven o'clock, continues free from complaint ; pulse 96. Sumat. opii gr. iſs.

January 14. Headach returned about four this morning, accompanied by ſome chillneſs, but without rigors. It went off about noon ; and again recurred about four P. M. At fix in the evening I ſaw him ; he was hot, the violence of headach was ſomewhat abated, and his pulse 112, full, and rather hard. Hora decubitus ſumat opii gr. ij.

15. Headach and rigors returned with violence, between one and two in the morning. I ſaw him at half paſt nine A. M. the headach was then ſomewhat eaſier, the chief pain confined to the left temple, and round the eye ; he is affected with coldneſs and tremors ; pulse counted at the flexure of the cubit 100, but it cannot be perceived at the wrift.

Forty-

Forty-five minutes after nine, I stopt the circulation in the left thigh and right arm.

At ten o'clock, headach relieved; complains of vertigo, and increased heat; pulse 100, and fuller, and now felt at the wrist.

Ten minutes after ten, headach entirely gone off; heat much increased; vertigo, and anxiety; pulse 100. The tourniquets were now removed.

Twenty minutes after ten, pulse now only 80, but rather smaller than before the removal of tourniquets; feels himself getting cold again, and the headach returns. The compressions were now renewed as before.

Thirty-two minutes after ten, headach continues; I now compressed the right subclavian, upon the first rib, with my finger, and allowed the tourniquets to remain as before; and

and in three minutes thereafter, the headach ceased, and he complained of vertigo and anxiety.

Forty minutes after ten, anxiety and vertigo greatly increased ; the candle, he says, appears double, and black spectra are seen. The compressions were all removed.

Fifty minutes after ten, anxiety and vertigo gone ; headach has not returned ; and he says, he feels himself quite well ; pulse 90, full and soft.

Thirty minutes after eleven, continues well ; pulse natural. Sumat pulv. cort. Peruv. ʒi, et repetatur unaquaque hora, donec sumperit ʒi.

At half past three P. M. having taken three dozes of bark, was seized with return of headach, slight rigors, and small pulse. I immediately

mediately compressed both subclavians with my fingers, and continued the pressure on the first rib for ten minutes, when the rigors ceased, the headach was relieved, his pulse fuller and stronger, and beat only 80. I was now fatigued with continuing the compression with my fingers, and applied a tourniquet on the left arm, as high up as possible. It was allowed to remain twenty minutes, and was then removed. The headach soon ceased; and his pulse rose in strength, and diminished in frequency. After the removal of the tourniquet, it continued at 80. A drachm of bark was now given, and ordered to be repeated every hour as before directed.

At half past six P. M. complains of slight pain in the left side of the head, which he terms a dullness; pulse small, but not quick. A tourniquet was applied on one arm, as high up as possible, and the compression continued for half an hour; the pain ceased, and the
pulse

pulse became fuller and softer. Con. pulv. cort. Peruv. et H. S. Sumat opii gr. ii.

16. Free from complaint this morning; pulse 70, full and soft. It appears, he has had no stool these two days. Sumat pil. cathartic. gr. xii. con. pulv. cort. Peruv.

January 17. Took ʒjss of bark yesterday; pulse and other functions natural. Con. pulv. cort. Peruv.

18. Took ʒj. of bark before noon yesterday. No return of symptoms. Complains of swelling of the fauces, and painful deglutition. Omit. cortex Peruv.

21. Returned to his duty, cured.

C A S E

C A S E III.

WILLIAM DUN,

Says that, for three nights past, he has been regularly seized, about eleven o'clock, with coldness and shakings, accompanied with pain in the loins ; these symptoms continue about one hour, and are then succeeded by increased heat, thirst, and headach, and that these last go off towards morning by a profuse sweat.

March 3. 1796.—Had no attack last night ; complains this morning of gripings, and frequent loose stools. Sumat stat. pulv. jalap ʒss, et vespere opii gr. iiss.

4. The paroxysm did not take place last night ; but this morning, about eight o'clock, he was attacked in the usual manner.

Thirty minutes after eight, he shakes violently ; features are much collapsed ; nose and ear feel cold. Complains of pain in the loins, and thirst ; pulse very small and quick. A tourniquet was applied on the left thigh, and another on the right arm, and the femoral and brachial arteries compressed.

Thirty-six minutes after eight, succussions have entirely ceased ; he begins to feel himself hot ; pulse 100, fuller and softer.

Forty-five minutes after eight, pain of loins gone ; he is not so thirsty ; pulse 100, and full. The tourniquets were removed.

At nine o'clock, he continues well ; his countenance is now natural and warm ; his tongue moist and clean ; pulse 100.

At noon, pulse 86. Hab. vini rubri ̄ iv.

March

March 5. Perspiration about nine last night ; slept well, is free from all complaint this morning ; pulse natural. Hab. vini rubri tri in dies.

8. No attack since the 4th instant. Con. vinum.

10. Returned to his duty, cured.

See also the cases of Humphries and Grey, related in my former letter.

2. For some time, I had thus confined my observations on the effects of compression to the few cases of intermittent complaints which fell under my care ; but as these occurred but seldom, I was at length induced to make trial of it in other febrile diseases.

Along with the many inconveniences, under which the navy-surgeon practices his art,
he

he enjoys at least this advantage, he sees his patients almost the moment they are taken ill, and has therefore an excellent opportunity of observing diseases in their first stages. The commencement of most diseases of the class pyrexia, resembles in many particulars the cold stage of an intermittent paroxysm. Fevers, catarrhs, and rheumatisms, are commonly introduced with lassitude and debility, chillness and rigors alternating, sometimes with partial heats, pain of the loins, and headach; and these symptoms I have known continue, with a small and frequent pulse, for several hours before the genus of the ensuing disease could be determined; for sometimes they are succeeded by a full, strong, and hard pulse, with or without phlegmasia; and sometimes, on the contrary, the pulse will continue frequent and small, with symptoms of great debility; and, lastly, the incipient disease is not unfrequently cut short by the timely administration of an emetic.

Nothing

Nothing is more common at the evening-visit on board, than to find a patient make his first appearance, complaining, that an hour or two ago, he was seized with pain, or weakness of his loins ; that he cannot keep himself warm ; that he is sick and thirsty. His tongue is neither foul nor dry, but unsteady when pushed out of his mouth ; and his pulse is frequent and small. A spoonful or two of a solution of tartarate of antimony are given, and repeated at intervals till he vomits ; he is then ordered to bed ; in the course of the night, he has perhaps a stool or two, and perspires towards morning, and gets up free from complaint.

Emetics, in like manner, administered in the cold stage of an intermittent, induce the hot one ; or given about the period of the expected paroxysm, sometimes entirely prevent it. Opiates, hot tinctures, and spices, have similar effects, both in intermittents and in the commencement of other pyrexiaë ; for it is com-

mon with many people, when seized with the symptoms of incipient disease above enumerated, to bathe their feet in warm water, drink a glassful of hot brandy and water, or spiced wine, and go to bed ; and it would seem, that fevers, catarrhs, and rheumatisms, are sometimes thus prevented. As compressions had been found to induce the hot stage of an intermittent, and to prevent the paroxysm, if used about the expected period of attack ; so from these analogies I had great hopes, that compression by the tourniquet might be equally serviceable in the incipient stages of other febrile diseases ; nor have these hopes been disappointed.

In such cases, the pulse became fuller, stronger, and slower ; if the patient was affected with coldness, and rigors, he became warmer ; the pain of loins, and headach vanished ; anxiety, nausea, and thirst, were relieved ;

ved; and in some cases, the symptoms thus relieved, or carried off, never returned.

3. Encouraged by success, and assured that, without danger, the most constant effects of compression were to reduce the frequency, and increase the vigour of the circulation, I ventured to use it in the more advanced stages of pyrexia.

4. In prosecuting these experiments, I observed, that besides moderating the fever, and reducing the frequency of the pulse, pains of the joints were relieved, and entirely carried off, especially when below the tourniquet. It was natural, therefore, to try what compression could do in chronic pains, and rheumatisms; and I have accordingly had the satisfaction of observing severe pains removed in a few minutes, after I had stopped the circulation in the affected limb, whether this had been affected by the tourniquet, or by

pressure with my fingers upon the subclavian artery, as it passes between the scaleni muscles, and over the first rib. Pains thus removed, have sometimes never returned; and when they did recur, it was commonly not until some hours after.

5. *Lastly*, In acute rheumatism, I have used compressions by the tourniquet with the happiest results; the pains were always removed; the heat and thirst diminished; the violent action of the heart and arteries moderated, the pulse falling frequently from 120 to 100, 90, and even 80, and continuing thus reduced for many hours after. The patient, before restless, and in agony, has thus enjoyed a respite, and fallen into a refreshing sleep.

6. Upon the whole, it will appear from what has been said, and from the following cases produced as examples,

1st, That compression by the tourniquet, in the incipient stages of pyrexia, will sometimes, like emetics, prevent the further progress of the disease.

2^{dly}, That in other, and more advanced stages of pyrexia, compression may be employed to moderate the symptoms, and reduce the frequency of the pulse.

3^{dly}, That when employed in acute rheumatisms, the vigor of the circulation, heat, and pains, are for a few minutes increased.

4^{thly}, But that in from five to fifteen minutes, the pains are totally removed; in fifteen or twenty minutes, the heat diminishes, and the pulse decreases in velocity.

5^{thly}, That on restoring the circulation, the pulse becomes still slower, and the temperature less.

6thly, That these symptoms thus relieved, or removed, seldom return for several hours after, sometimes not for a whole day; and that the following attacks are less severe than the preceding ones.

7thly, That if the compression be continued half an hour, or longer, drowsiness, vertigo, anxiety, and tendency to delirium, are induced; but that though these effects are to be avoided in the cold stage of intermittents, in the incipient stages of pyrexia, and in all cases of arterial debility, they yet appear serviceable in acute rheumatisms, and in all cases where the inflammatory diathesis exists.

8thly, That in acute rheumatisms, the tourniquets should be applied on the affected extremities.

9thly, That rheumatic pains, without fever, may be thus certainly removed or relieved.

C A S E

C A S E I.

G E O R G E T R I P.

February 6. For these three days past, has complained of frequent chills, succeeded and alternating with flushings of heat; constant dull headach; loss of appetite; pulse about 112, small and weak. At half past nine A. M. I applied a tourniquet on one thigh, and another on the opposite arm.

Forty-five minutes after nine, headach gone; heat increased; pulse 120.

Ten o'clock, anxiety and faintness; pulse still 120. The tourniquets were now removed.

Ten minutes after ten, continues free from headach; pulse fallen to 90.

He continued free from headach till four in the afternoon, when it recurred, but without being accompanied with cold or rigors.

Twenty minutes after six P. M. complains of headach and thirst; pulse 100. The tourniquets were applied as in the morning.

Twenty-five minutes after six, headach gone; pulse 120.

Thirty-five minutes after six, pulse 80, full and soft; complains of anxiety and faintness. The tourniquets were removed, he went to bed, and rising next morning free from complaint, returned to his duty.

C A S E II.

THOMAS CROUCH. Æt. 20.

Was seized about four in the afternoon, April 8. with severe headach, pain in the loins, legs,

legs, and arms. At six in the evening, I saw him, and he then complained of thirst, heat, and fever; his pulse 128, full and strong. He said, he had found himself very unwell the whole day, and that before he was attacked with the violent pains and fever of which he now complained, he was affected with cold and rigors.

At six P. M. I compressed both femoral arteries, as high up as the tourniquets could be applied.

Ten minutes after six, pains of extremities, and headach gone; pain of the loins easier; pulse only 100, and softer.

Twenty minutes after six, pain gone from the loins; complains of some anxiety, faintness, and vertigo; the flame of the candle appeared to him clouded; he then said, he saw it double; and shortly after, declared he
could

could not see at all; his pulse was now rather smaller and harder. The tourniquets were removed, and these feelings went instantly off; his pulse again became full and soft, and beat 100. He complained of being rather cold, but this soon ceased. He continued free from pain, heat, and fever; and within an hour he was found asleep.

April 9. Slept well, and remained free from pain, till about four in the morning, when he had some return of it in the loins, which still continues; pulse 100, full and soft; heat natural; no thirst. Sumat pulv. antim. gr. viij. tertia q. q. hora.

10. Slept well, and perspired during the night, pain of the loins gone; complains of slight pain in the hip-joint this morning; pulse natural.

11. Returned to his duty.

Thomas

Thomas Juneaux, and Thomas Colston, were taken ill on the same day ; their complaints were much alike ; I thought therefore it might be worth while to employ compression in the one case, and some more usual remedy in the other.

C A S E I I I .

T H O M A S J U N E A U X .

April 21. 1796.—Complains of headach, pains in the loins and extremities ; nausea, anorexia, and feebleness ; thirst, and increased heat ; pulse 120, small, but rather hard. He was attacked this morning with rigors, and constant yawning, which were succeeded by the above symptoms.

At six P. M. I stopped the circulation in both the lower extremities, by compressing the
femoral

femoral arteries a little below the groin. The pains soon left his legs, and the headache ceased ; but the pains continued in his arms. I now compressed the brachial arteries, the pains went off ; and he soon after declared, the nausea and oppression were relieved. In fifteen minutes from the first application of the tourniquets, the pain left his loins. The compression was now removed from his arms, and his pulse was found to be 100, and much fuller and softer than at first.

Twenty minutes after six, the tourniquets were removed from the lower extremities ; and he was sent to bed.

22. Slept tolerably, awoke about four in the morning, and thought himself then quite well. At nine A. M. says he feels some pain in his left loin ; pulse 100, and soft.

23. No complaints ; returned to his duty.

C A S E

C A S E IV.

THOMAS COLSTON.

April 21. Complains of alternate cold and hot fits, headach, pain of loins and the extremities, with a sense of lassitude, and forenefs of his whole body; pulse 120, rather small; was first attacked this morning.

22. Slept indifferently, and was hot and restless during the night; complains much of the pains in his loins and extremities; thirst, disagreeable taste in his mouth; complains also of pain and tightness of the chest, cough, and gravedo; pulse 120, and hard. Sumat tertia q. q. hora, pulv. antimon. gr. xij.

23. Has had five stools, perspired a little during the night; the pains of his limbs are easier.

The

The symptoms as yesterday. Cont. pulv. antimon.

24. Pain of breast gone ; headach easier ; complains still of his loins and thighs ; pulse 112, and soft. Cont. pulv. antimon.

25. Symptoms as yesterday ; has had no stool these two days. Omitt. pulv. antimon. fumat pulv. jalap. comp. 3j.

26. Had five stools ; every complaint gone, excepting some pain of his loins, and slight cough.

28. Returned to his duty, cured.

CASE

C A S E V.

GEORGE HOLLINGSWORTH.

May 15. 1796.—Complains of languor, lassitude, pains in the loins and shoulders, dryness of mouth, and fauces; pulse 80.

Nine A. M. I compressed, with the tourniquet, both femoral, and one brachial artery,

Fifteen minutes after nine, pains entirely gone off; pulse 70, fuller and stronger. The compressions were removed.

Six P. M. no return of pains; complains still of lassitude, of vertigo, and thirst; pulse 80, and small. Sumat pulv. ipecac. gr. xv.

May 16. Emetic operated well; complains
still

still of lassitude, and dull pain, which he terms a heaviness in his forehead. Belly costive; pulse 81. Sumat pil. cathartic. gr. xij.

17. Returned to his duty, cured.

C A S E VI.

WILLIAM PRITCHARD.

May 21. Was taken ill last night, and complains this morning of lassitude, headach, pains in his thighs, legs, and back; inflammation of the tonsils, and painful deglutition.

At thirty-five minutes after nine A. M. he is rather cold than hot, and complains that he cannot get himself warmed; pulse 138, exceedingly small and weak. The circulation was stopped in both thighs, and in the left arm.

Forty-

Forty-five minutes after nine, headach and pain of back gone ; pains continue in the extremities, but are less severe ; pulse 120, fuller and stronger.

Fifty minutes after nine, pain gone from the extremities ; pulse fallen to 100, very full and soft ; is somewhat faint and sick ; tourniquets were all removed, and sickness went off.

Fifty-five minutes after nine, continues free from all pain ; pulse 112.

Fifteen minutes after ten, pulse 112, and of good strength.

Vespere. No return of the pains in his extremities, or loins ; complains much of his head ; fauces are more tumid and painful ; pulse 130, and small.

The instant a tourniquet was applied,

E

and

and had obstructed the circulation in one thigh, he became sick, and vomited ; it was therefore removed, and the attempt for the present laid aside.

Sixty grains of nitre were given, dissolved in a pint of cold water ; and in a few minutes after, his pulse fell to 120.

May 22. Slept indifferently, and was very hot, and thirsty, during the night ; complains chiefly this morning of the swelling of his fauces, and difficult deglutition ; pulse 130, small and oppressed.

Nine A. M. Sumat fal. nitri ʒiss, in aq. frigid. ʒi. solut.

Meridie. Symptoms as in the morning ; nitre has no evident effect. Sumat nitri ʒij. The pulse, after taking the nitre, was attended to for about a quarter of an hour, but it underwent no alteration.

Six P. M. has had three plentiful stools ; and finds himself much relieved ; his head-ach is gone ; fauces less painful, and his skin is not so hot ; pulse 120. Sumat falis nitri ʒij.

May 23. Slept well, and perspired copiously during the night. Has had two more stools, and finds himself easier this morning ; pulse 120. Sumat fal. nitri ʒfs in aq. font. ʒj solut. Half an hour after swallowing the nitre, his pulse was 130, and smaller than before ; but he found no other effect from it.

Meridie. Some gripings of his bowels about an hour after taking the nitre. Has had three stools since ; pulse now 120, fuller and softer.

Six P. M. has had another stool since noon, and perspired very copiously ever since ; urine no way increased ; pulse 120.

24. Slept very well, and continued to perspire during the night; has had one stool this morning; throat still painful and swelled; pulse 118, full and soft. Omitt. nitrum illinantur fauces externæ liniment. camph.

25. Pulse 100; convalescent.

27. Returned to his duty, cured.

C A S E VII.

ZACHARIAH STEVENS.

June 4. 1796.—Was attacked last night with pains in his back, loins, and headach; complains now of general foreness of his body; pains in his extremities, headach, and fore throat; skin hot; tongue clean, and steady; pulse 120, and rather hard.

At six P. M. I compressed both femoral arteries, and the left subclavian. The compressions

sions were continued twenty minutes ; the pains first left his loins, then the extremities, and lastly his head ; he became drowsy, and his pulse fuller and softer, but not slower. On removing the tourniquets, his pulse fell to 100.

5. Complains of fore throat, and slight headachs this morning ; but has had no return of other pains ; pulse 90, full and soft. Sumat statim sal. Glaub. 5x, et vespere habeat haust. diaphoret.

6. Had five stools ; slept tolerably, but perspired none ; has no headach this morning ; throat easier ; pulse 100. Sumat mane, meridie et vespere pulv. antimon. gr. x.

7. Convalescent, &c.

9. Returned to his duty, cured.

C A S E V I I I .

S A M U E L Y A T E S .

June 19. After exposure to much rain, while on duty at the helm, was seized with coldness and tremblings, pain in his loins, and headach. At eight in the evening, about two hours from his first being attacked, he came below, complaining much of his loins and head, and of pains in his knees and hips; he was then very hot; and his pulse full and strong, 108. Tourniquets were immediately applied to both thighs, and to one arm; and the compressions were thus continued for half an hour. The headach, and pains of limbs, were very soon relieved, and shortly ceased; but that of his loins was rather increased, and his pulse became quicker and smaller. But in three minutes after the removal of the compressions,

pressions, the pain of loins went entirely off, his pulse fell to 80, and soon after rose to 90. Sumat pulv. antimon. gr. xij. tinct. opii gr. xx.

20. After going to bed last night, he became very hot, and the pain of loins returned, but again went off before morning. He has now no other complaint than a slight head-ach. Both subclavians were compressed for half an hour, and the headach ceased. Sumat fal. glaub. ʒi.

21. Returned to his duty, cured.

CASE IX.

CHARLES KING.

June 21. Last night, about eight o'clock, after some chillness and shaking, was seized with headach, and pains in the extremities.

E 4

During

During the night, he was uneasy, hot, and restless, and this morning complains of general debility, headach, pains in his legs and arms, heat and thirst; tongue white and moist, but steady; pulse 100, of natural strength.

At nine A. M. both femoral arteries were compressed a little below the groin.

Ten minutes after nine, pains of the lower extremities have ceased; headach, and pains of arms, continue as before; pulse 112, fuller and stronger. I now compressed both subclavians upon the first rib. The pains of arms were almost immediately relieved, and soon ceased. In five minutes after, the headach went off. The compression of the subclavians having been continued eight minutes, he became heavy, drowsy, and vertiginous, and the drops of sweat stood on his face. The tourniquets were now removed from his thighs, and the compression of the subclavians discontinued;

tinued ; his pulse fell immediately to 90, and in five minutes after to 80, and he remained free from headach and pains,

Vespere. Within an hour after the discontinuance of the compression, the pains returned in the lower extremities ; continues free from heat, thirst, headach, and other pains ; pulse 90, and of good strength. Tourniquets were now applied to the thighs, and the compressions continued for fifteen minutes. The pains very soon ceased ; he complained of drowsiness, and his pulse rose to 120. On removing the compressions, it fell suddenly to 100, then to 80, and in a few minutes after, rose to 100 again. He now went to bed, without any complaint.

22. No complaints ; pulse natural.

23. Returned to his duty, cured.

C A S E

C A S E X.

WILLIAM ROBERTS.

January 6. 1796.—Complains of pains in the hips, groins, and knees, with which he was attacked yesterday; thirst; tongue white; pulse about 100. Sumat pulv. antimon. gr. vi. tertia q. q. hora.

7. Vomited yesterday, and had two stools; slept badly, and perspired none. Complains still of pains, heat, and thirst; pulse 100, and rather small. Sumat pulv. Doveri 3i et repetatur vespere.

8. Vomited once; slept well, and perspired copiously during the night. Sumat statim pulv. Doveri gr. x. atque repetatur meridie, et vespere.

9. Perspired plentifully, and finds himself much relieved this morning ; pulse 100, full and soft. Cont. pulv. Doveri ut heri.

10. Pains get daily better. Cont. pulv. Doveri.

11. Every complaint gone, excepting a severe pain in the right knee ; pulse and functions natural. Omitt. pulv. Doveri.

12. Pain continues severe in the right knee.

At nine A. M. I applied a tourniquet in the ham, and compressed the popliteal artery, and in five minutes thereafter the pain entirely ceased. About eight minutes after, he drank a cupful of cold water, and immediately after, complained of pain in his right side, impeding respiration. The tourniquet was immediately removed, and his side was rubbed with camphorated liniment, till the pain went off.

13. No return of pain in the knees ; but the pain of his side soon recurred yesterday ; and was finally removed, by dry cupping.

14. Has no complaint.

15. Returned to his duty.

C A S E X I.

H U G H D U N C A N.

January 15. 1796.—For four days past, has complained of a severe lumbago. The pain is chiefly situated in the right lumbar region, is increased by an erect posture, but relieved on bending forwards ; pulse 104.

Thirty-five minutes after ten A. M. I compressed the femoral artery of the right thigh.

Fifty

Fifty minutes after ten ; the pain of his loins has undergone no sensible alteration ; pulse 112. The circulation was now obstructed in the other thigh.

Fifty-five minutes after ten ; declares the pain has entirely left his loins ; he rose up, and bent his body in every direction, coughed repeatedly ; and he said the pain was just perceptible on making these exertions.

Eleven o'clock, complains of vertigo, indistinct vision, and anxiety ; pain of the loins not perceptible on moving or coughing ; pulse 120, full and strong. The compressions were removed.

Twenty minutes after eleven, pulse only 84 ; on bending his body, and coughing, perceives what he calls a dull pain in his loins. This continuing, was in the evening entirely removed by a renewal of the compressions.

16. No return of pain ; went to his duty, cured.

C A S E XII.

WILLIAM WISTLE.

February 29. 1796.—Has complained for these fourteen days past, of a rheumatic pain in the right elbow, and muscles in the inside of the arm. The brachial artery was compressed for half an hour, the pain was effectually removed, and never returned.

C A S E XIII.

GEORGE MORTON, *Æt.* 20.

February 4. 1796.—Complains of acute pains in his loins, hip-joints, knees, and ancles ; face flushed, heat and thirst urgent ;
pulse

pulse 100, full and strong. Fiat V. S. ad 3x.
 Sumat pulv. antimon. gr.viij, tertia q. q. hora:

5. Pain of loins relieved ; pains in both knees still very severe, and the left is considerably swelled, and puffed, about the patella ; pulse 120, and soft ; thirst and heat continue.

Thirty minutes after nine A. M. I compressed the popliteal arteries. The pains were at first rather increased, but in five minutes they became much easier.

Forty minutes after nine, pains have entirely ceased in both knees ; and though he could not before move a limb, he can now bend them to and fro, without suffering ; pulse about 120, fuller, harder, and stronger.

Fifty minutes after nine, continues free from pain ; pulse now 108, is soft, and not so full ; heat, which was at first increased, is now diminished,

diminished, and his skin feels cooler than it did before the compressions were made.

At ten o'clock, the tourniquets were removed.

Ten minutes after ten, no return of pains ; moves his legs with freedom ; pulse 100, and soft. He now walked up from the cockpit to his hammock on the deck above ; whereas he was before in such pain, that it was with difficulty he had been carried down by two of his messmates.

Eleven o'clock, he is in his hammock, and continues free from pain : a slight headache which remained, is now gone off ; skin feels cool ; he is not thirsty ; pulse only 92.

Six P. M. about half an hour ago, was seized with numbness, and coldness of the
right

right arm, succeeded by a return of pain in the elbow, wrist, and knee of the same side.

Thirty-five minutes after fix, pains are very severe; heat great; face very much flushed; pulse 120, full and strong. The right subclavian was now compressed. The compression was continued half an hour; the pains of elbow and wrist now entirely ceased, but that of the knee continued without alteration; the pulse fell to 112. The tourniquet was then removed from the arm, and applied to the right thigh; and in fifteen minutes the pain entirely left the knee, and the pulse was 104: the compression was then discontinued.

At eight o'clock, remains free of pain; skin cool; pulse 100. Sumat mox pulv. Doveri ʒj; atque cras mane, pulv. jalapii comp. 5j.

February 6. Was again attacked about mid-

F

night

night, with a return of pain in almost every joint ; heat, thirst, and fever.

Twenty-five minutes after nine A. M. pains in both knees, and in the elbows and wrists of both arms ; pulse 120, and rather hard. The circulation was obstructed in both arms. The pains were for a time rather more severe, but ceased in about ten minutes.

Forty minutes after nine, he is cooler, and the pains of his knees have ceased.

Ten o'clock, the tourniquets were removed from his arms.

Ten minutes after ten, continues free from pain ; pulse 100, and soft ; skin cool. The jalap, which was taken at six this morning, has had no effect. Rep. pulv. jalap. comp.

Thirty minutes after ten, pulse 84, remarkably

ably full and soft ; some return of pain in his wrists ; and he begins to feel himself hotter.

Forty minutes after ten, the pains continue in both wrists, but most severe in the right ; pulse 84. The circulation was stopt in the right arm and left ham.

Fifty-two minutes after ten, the pains have ceased in both wrists.

Seven minutes after eleven, anxiety and faintness ; pulse 120, and small. The compressions were discontinued.

At one P. M. continues free from pain ; pulse 100. Has had no stool yet. Rep. pulv. jalap. comp.

Thirty minutes after six P. M. no recurrence of pain. He is now in bed, and quite easy, though rather hot ; pulse 100, full and

soft. Sumat pulv. antimon. gr. xij. et rep.
hora octava vespere. Bibat decoct. avenæ
ad libitum.

February 7. Had five stools during the night;
continues free from pain; skin rather hot, but
moist; pulse 90, full and soft. Sumat pulv.
antimon. gr. x. tertia q. q. hora. Decoct.
avenæ, et infus. theæ ad libitum.

At eleven A. M. he perceived some return
of pain in the right arm. Tourniquets had
been left on his extremities, with directions to
him to tighten them the instant he should dis-
cover any pain. He accordingly himself
screwed tight the tourniquet on his arm, and
the pain ceased in a few minutes.

At seven P. M. the pain again returned,
and was again relieved by immediate com-
pression.

February

February 8. Has continued free from pain ; perspired towards the morning ; pulse 90, and soft. Con: pulvis antimonialis.

February 9. Slept well, and perspired copiously during the night ; continues free of pain ; had one stool last night ; pulse 68, full and soft. Omit. omnia.

10. Convalescent.

17. Had daily convalesced from the 10th, without any return of pain whatever. But was last night seized with coldness in one of his arms, soon succeeded by pain in the thumb, of which, together with pain in his left knee, he still complains. Pulse 90, and small.

At nine A. M. the circulation was stopt in the affected extremities, and the pains went off.

Six P. M. pains have not recurred ; but he now complains of chilling fits, alternating with partial hot ones, lassitude, and thirst ; pulse 120. The circulation was suppressed in the left thigh and right arm.

Fifteen minutes after fix, pulse only 100 ; heat increased.

Thirty minutes after fix, great increase of heat, anxiety, and faintness ; pulse 100. The compressions were removed.

Thirty-five minutes after fix, feels himself rather cold ; pulse 100, full and strong in the arm which had been compressed, but smaller in the other.

Forty minutes after fix, pulse 100, and in both arms full and soft ; heat natural ; finds himself every way relieved. Sumat pulv. antimon. gr. x. tinct. opii gt. xv.

February

February 18. Vomited about nine o'clock last night, and was shortly after seized with pain in his right knee; slept badly; complains this morning of pains in both knees, particularly in the right, which is considerably swelled; pulse 100.

At nine A. M. compressions were made on both legs above the knees.

Ten minutes after nine, pains have ceased.

Fifteen minutes after nine, tourniquets were applied on both arms.

Thirty minutes after nine, vertigo and faintness. All the tourniquets were removed.

Forty-five minutes after nine, pulse 84, full and soft; no return of pain. Sumat mox pulv. jalapii \mathfrak{z} ij.

Six P. M. has had several stools; the pains returned in the knees about two in the afternoon, which, though much flighter than in the morning, still continue. Tourniquets were applied as before; the compressions continued, till faintness was induced; the pains were removed, and he went to bed free from complaint.

19. No return of pain; slept badly, having been much disturbed by unavoidable noise: feels fatigued this morning; and complains of headach, languor, lassitude, and foreness at the epigastrium; pulse 84, and small. Habeat vini Hispalens. ℞fs.

Six P. M. was attacked about ten this morning, and now complains of pain and swelling of both knees, more especially the left; thirst, hot skin, and flushed face; pulse 100, and hard. I stopt the circulation in the left thigh.

Ten

Ten minutes after six, pains of both knees relieved, and the swelling of the left is evidently diminished. The tourniquet was removed from the left, and applied to the right thigh.

Twenty-five minutes after six, pain and swelling entirely gone from the right knee; but the left is now rather more pained than before. The tourniquet was again changed from the right to the left thigh.

Forty-five minutes after six, pain of the left knee entirely gone; swelling greatly lessened. The tourniquet was removed; and he moved both knees without feeling any pain. Sumat pulv. antimon. gr. vi.

Thirty minutes after seven, continues free from pain; pulse 100, full and strong. Tourniquets were applied to both arms, and to both thighs; and the compressions directed to be continued till he became faint.

Forty.

Forty-five minutes after seven, very faint. The compressions were removed from one arm and one thigh.

At eight o'clock, the tourniquets were removed from the other two extremities.

Five minutes after eight, pulse 90, full, and strong; skin cool; remains free from pain. Repet. pulvis antimon.

At nine o'clock, pulse continues at 90.

At ten, seems inclined to sleep; is free from pain; begins to perspire; pulse 112, and soft. Repetatur pulvis antimonialis.

February 20. Perspired copiously, but slept indifferently during the night; was seized with pain in his left arm about eleven last night; and about seven this morning his knee was affected.

Thirty minutes after nine A. M. complains
of

of severe pain in the right elbow and wrist, which last is also considerably swelled, and slighter pain, and swelling of the left knee ; pulse 112 ; skin hot. Compressions were made on the left arm and right knee, and directed to be continued till he should complain of anxiety, vertigo, or faintness.

In half an hour, these feelings became troublesome ; but the pains were not relieved, and that of the knee he thought rather increased ; pulse 120, full and strong.

Ten o'clock, the tourniquets were removed.

Five minutes after ten, pain and swelling continue in the right arm and left knee ; pulse fallen to 100 ; faintness gone. The compressions were now made on the right arm and left thigh.

Fifteen minutes after ten, pain gone from the knee, that of the wrist relieved ; pulse 100, very soft ; feels himself cooler.

Twenty

Twenty minutes after ten, the pain of the wrist has now ceased, and its swelling is considerably diminished ; pulse 100.

A vein was opened on the back of the carpus, which discharged about three ounces of very black blood ; and the swelling of the wrist entirely subsided.

Thirty-five minutes after ten, complains of being very faint. The compressions were discontinued. On the removal of the compression from the arm, the vein, which had been opened, again discharged freely, and ziv. of blood were allowed to run off, which appeared thinner, and of a more florid colour, than that which the same orifice discharged during the continuance of the compression.

At eleven o'clock, no recurrence of pain ; skin cool ; pulse 96.

Six P. M. was seized about four in the afternoon with pain in the right shoulder, which still continues, but he has no other complaint; pulse 112. I compressed the subclavian artery above the clavicle, and in a few minutes the pain left the shoulder. I continued the compression, however, with some little interruption, occasioned by my own fatigue, for half an hour.

Seven o'clock, the pain of the shoulder has not returned. Sumat pulv. antimon. gr. xij.

February 21. Slept some, and perspired plentifully during the night; continues quite free from pain; perspiration continues; pulse 100, full, and soft. Sumat pulv. antimon. gr. vi. secunda q. q. hora. Bibat. decoct. hordei ad libitum.

22. Slept tolerably, and continued to perspire all night. Bleeding from the nose
about

about eight last night ; is free from complaint this morning ; continues to perspire ; no evacuation by stool for two days. Sumat fal. Glaub. ʒj.

23. Perspiration ceased about noon yesterday ; had afterwards two stools. In the afternoon he was washed with warm water and soap, and shifted ; and ate some bread, with four ounces of Spanish white wine : slept well ; skin cool ; pulse 100 ; a slight pain in the wrist was removed in a few minutes by compression. Habeat vini Lusitan. ʒiv.

Vespere, got out of bed, and remained up the greater part of the day. Has had two stools, and some bleeding at the nose ; pulse 84. The pain having returned in the wrist, was again removed by compression.

February 24. Slept well ; complains of slight pain in his left shoulder this morning ;
pulse

pulse 90; feels a return of appetite, and craving for solid food. Habeat vini Lusitan. ℞fs.

Vespere, one stool since morning; has been out of bed all day, and ate some soup and boiled beef with good appetite; pulse 90; the pain of his shoulder continuing, I compressed the subclavian with my finger, and in a few minutes the pain went off.

25. The pain of his shoulder has not returned; pulse 80; appetite continues; full diet, and wine, as yesterday.

26. Pulse 70; continues to convalesce.

March 5. Returned to his duty, cured.

S E C T.

S E C T. III.

“ QUOD si omnes observationes, et omnia
 “ remedia quæ prolata sunt, quam optimæ fuif-
 “ sent, *theoria* quadam non eo minus opus ef-
 “ fet; nempe ut sciret medicus quando conve-
 “ nient remedium dare, quando et quo consilio
 “ omittere, et mutare, prout res mutatæ pos-
 “ tulassent.”

Conspect. Medicin. Theoret.

Auctore Jacob. Gregory,

Prolegom. p. 66.

(1.) Though the doctrines of plethora, of derivation and revulsion, as formerly taught, are now in a great measure banished from medical science, it is yet well known to physicians, that the proportions of circulating fluids vary considerably in the same vessels at different times, and that, in weak people especially, changes in the distribution of the blood

are

are effected by seemingly very slight causes, and produce often considerable effects.

The pulse of patients labouring under diseases, attended with great debility, is often astonishingly accelerated and enfeebled by an erect posture, which sometimes too induces syncope. On removing the bandage with which the veins had been compressed in the operation of blood-letting, many people fall into deliquium animi, from which again they are quickly relieved by a recumbent posture. When the fluid, which in ascites distended the abdomen, and supported and compressed the blood-vessels and viscera of that cavity, is drawn off by the operation of tapping, patients are liable to syncope, and even sudden death. But these dangerous effects are now prevented by artificial compression with a bandage, first proposed by Dr Mead.

(2.) Whatever explanation we adopt of

G

these

these facts, it seems certain, that the compression of one or more large arterial trunks must occasion, in every other part of the system, what has been termed by physiologists a *plethora ad spatium*. For it appears evident, that the blood discharged by each systole of the heart will then circulate through a lesser system, than when the circulation is free in all parts of the body. This, which seems so clear *a priori*, is proved *a posteriori* from the changes induced in the system by compression; such are, increased heat, a fuller and stronger pulse, anxiety, and anhelation, a sense of heat and fullness about the præcordia, heat and turgidity of the face, vertigo, and the evident repletion of the veins of the head, face, and neck, sometimes observed.

(3.) It would also seem, that this plethora may take place in a greater degree in some parts of the system than in others, and that variations in this respect will depend on the
parts

parts of the body compressed. When the subclavians, for instance, are compressed, it is perfectly evident, that the volume of blood thrown into the common trunk of the carotid and subclavian, and which would otherwise be divided between these, can now only pass through the former, and that consequently a greater quantity of blood will be circulated through the head. That a more plethoric state is thus induced in the brain, than if the compression had been made on the iliacs, is proved from observing, that the patient sooner complains of drowsiness and vertigo ; and that the headach which attends the cold stage of intermittents, and the incipient stage of some other pyrexia, and which, like the hemicrania, is probably caused by defect of stimulation, is sooner removed when the subclavians, than when the iliacs, are compressed, although these last are the larger trunks.

On the contrary, when the compression is

made on the external iliacs, the plethora will exist chiefly in the branches of the internal iliacs, the cæliac, mesenteric, and emulgent arteries; and hence lumbago, and the pain of the loins in the cold stage of fever, are most effectually and speedily removed when the tourniquets are applied to the lower extremities.

Thus, in ammenorrhæa, it has been proposed to stimulate the uterine vessels, by determining the blood more copiously into them, by compressing the external iliacs; and if the trials of this kind hitherto made have seldom succeeded, the failure may be attributed partly to the timidity of the operator from preconceived apprehensions of internal hæmorrhagy, but chiefly, as I apprehend, to this circumstance, that such large arterial trunks as the iliacs cannot be compressed for a sufficient length of time, without vertigo and deliquium being induced.

Again,

Again, in all cases where any considerable trunk of the arterial system is compressed, the plethora will be considerably felt in the lungs, in like manner as takes place in corpulent people, and in such as have narrow and disproportionate chests; and hence the anxiety, heat, and anhelation.

(4.) As by compression plethora is induced, as a greater quantity of blood passes through the heart and lungs in a given time, and as a larger supply is sent to the brain and other viscera, it seems clear, that they will be stimulated into greater exertions. And accordingly we find, that the effects of compression much resemble the changes induced in the system by other stimuli.

The effects of compression, are increased vigour of the circulation; and in intermittent paroxysms, the removal of the atony, or quiescence of the arterial system. And such

effects we daily experience from opium, alcohol, and other stimulants.

In diseases with arterial debility, where we have a frequent, small, weak pulse, small doses of opium or alcohol increase the vigour, but diminish the frequency of the pulsations; and so does compression by the tourniquet.

What are called cold pains, as hemicrania and chronic lumbago, seem caused by defective excitement, and are removed by opium, æther, and compression.

Therefore plethora is induced; and the system in general, and more particularly the viscera, are excited by compressions.

(5.) But as the long or continued operation of any stimulus at length produces an inert or quiescent state of the system, so if the compression be too long continued, the pulse, which
was

was at first excited into more energetic action, becomes again slower and softer ; or, if in the cold stage of intermittent fever, the pulse, from being frequent, small, and weak, has by compression been rendered slower, fuller, and stronger, it will again return to its former frequency and smallness.

It is on this principle we are able to explain the seemingly opposite effects of compression in intermittents and acute rheumatism.

In the former, the arterial system is affected with atony, the additional stimulus therefore given by compression produces more vigorous pulsations ; but if the compression be long continued, we have found that the atony will recur, and the pulse become again small and feeble. In acute rheumatisms, the phlogistic diathesis, which it would seem is a high state of excitement in the sanguiferous system, prevails, and the additional stimulus from com-

pression, here, as in the former case, at first increases the excitement: but the reverse much sooner happens; for, as in Morton's case, the pulse, though at first more energetic, very soon becomes slower and softer.

In the cold stage of intermittents, therefore, and wherever the arteries seem in an atonic state, the compression should not be continued any longer than what is sufficient to establish an increased excitement; and ten or fifteen minutes will commonly be found long enough. But where the phlogistic diathesis exists, the compressions should be continued till vertigo and tendency to delirium are induced, and the patient complain much of these symptoms; and the violence of the action of the heart and arteries will then be found much diminished.

Thus all agents, which by their operation on the organized fibre produce motion, at
length

length cease to have this effect; and it seems highly probable, that the quiescent state of the fibre which follows its contraction, is caused by the waste or expenditure of the principle of life, and that a time is required for a new supply of it, before the same agent can again produce the same effect. The animal fibre, then, may be supposed to be in an alternating state of plus and minus, with regard to this principle.

These are the excitement and collapse of the nervous system, according to the late Dr Cullen, the accumulated and exhausted excitability of the Brunonians, and the accumulation and exhaustion of censorial powers, according to the author of *Zoonomia*; all expressions for one and the same fact, with obscure references to the cause of that fact, which, like that of gravitation, being beyond the acumen of human intellect, has been the source of much unnecessary caville and logomachy.

It remains, however, certain, that all stimuli, by their violent or continued operation, produce first increased, then decreased exertion, and finally quiescence of the moving fibre; and such appear the effects of compression.

(6.) There is still another way in which the system may be affected by compression.

The energy of the brain, or, if you will, the secretion of sensorial powers, would seem to depend much upon a certain fulness or tension of its blood-vessels: and hence it is diminished by great or sudden depletions, as by hæmorrhages, and by an erect posture, as is experienced by weak and exhausted patients.

Now, in the cold stage of an intermittent, the energy of the brain is no doubt greatly diminished; and as compression occasions a
greater

greater fullness and tension of the blood-vessels of that viscus, and at the same time puts a speedy end to the symptoms of the cold stage, it would appear, that the energy of the brain is thus excited, or perhaps sensorial powers secreted.

But if, by a continuance of the compression, the fullness and tension of the blood-vessels of the brain be increased beyond this, instead of an increase of excitement, that viscus will in some degree be itself compressed, and a kind of apoplectic state be induced. Hence the energy of the brain will be again diminished.

In some, as in Morton's case, where the compressions have been continued for twenty minutes, or half an hour, we accordingly find, that drowsiness and vertigo were induced, and the violent action of the heart and arteries at the same time diminished.

It

It is proposed by the ingenious author of *Zoonomia*, in inflammatory fever, to still the violent action of the heart and arteries by *gently compressing the brain*.

“ This,” says Dr Darwin, “ might be done by suspending a bed, so as to whirl the patient round with his head, most distant from the centre of motion, as if he lay across a millstone.

“ For this purpose, a perpendicular shaft, armed with iron-gudgeons, might have one end pass into the floor, and the other into a beam in the cieling, with an horizontal arm, to which a small bed might be readily suspended.

“ By thus whirling the patient with increasing velocity, sleep might be produced, and probably the violence of the action of the heart and arteries might be diminished in inflammatory

flammatory fever ; and as it is believed, that no accumulation of sensorial power would succeed a torpor of the origin of the nerves, either thus produced by mechanical compression, or by the bladder-cap of cold water above described, the lives of thousands might probably be saved, by thus extinguishing the exacerbations of febrile paroxysms, or preventing the return of them."—*Zoonomia*, vol. II. *sup.* i. 15. 7.

We have just shewn, that the brain may be gently compressed, that sleep may be produced, that the violence of the action of the heart and arteries in inflammatory fever may be diminished, and that the exacerbations of febrile paroxysms may be extinguished or prevented by compression by the tourniquet.

I would therefore propose, instead of Dr Darwin's method, in all cases where such compression

pression of the brain seems indicated, to compress the two subclavian arteries as they pass over the first rib. Such a compression continued for fifteen minutes, or half an hour, will, I know, have the desired effects : It is without danger, of easy execution, and has this advantage over the mode proposed by Dr Darwin, that it may at all times be effected without the removal or disturbance of the patient.

(7.) Whatever be the state of the system at large, when the circulation is obstructed in any extremity, the parts below the tourniquet become quiescent, the arteries cease to act, and the blood accumulates in the veins. The blood thus detained in the compressed extremity, would seem by its suffering a further disoxygenation, to become less stimulating. And it is more especially evident, that if, while the arteries are compressed, a vein be opened below the ligature, and the blood
draw

draw off, the vascular system of that limb will be still less stimulated.

From this deficiency of accustomed stimuli in the compressed limb, and the consequent suspension of its functions, there must follow a saving in the expenditure of sensorial power, an accumulation of the excitability in its arteries, &c. ; a circumstance fully proved from this observation, that, on restoring the circulation, the pulse is found fuller and stronger in that arm than in the other, which had not been compressed. It is probable also there may be some saving in the expenditure of sensorial power, from the compression which the nerves themselves suffer from the tourniquet.

Thus, then, we explain the effects of compression in pains of the joints and limbs. Such pains as those, for instance, of acute rheumatism, are caused by the increased exertion or activity of the vessels of the inflamed ligament,

and

and they consequently cease when, by compression, the inflamed vessels are rendered quiescent; and the tumefaction of an inflamed part is reduced, when the compressed vessels are drained of their contents, by opening a vein below the tourniquet.

Might not inflammations of the extremities be speedily cured by compressing the arteries, supplying the affected parts, and then emptying the inflamed vessels, by opening a correspondent vein, or by scarifying the inflamed surface?

In the incipient state of white-swellings, and in acute inflammations of the joints, might not such a practice be useful?

LETTER

LETTER III.

*His Majesty's ship Leopard,
15th October 1796.*

IN former letters I have furnished you with several cases as examples of the successful effects of compression. But I must not conceal from you, that I have sometimes been disappointed ; and that this, as a remedy, is, like all others, precarious, and variable in its effects.

About a fortnight ago, I had two agues under my care. In the one case, compression was attended with its usual effects, the pulse rose, the succussions ceased, and the hot stage was induced. But in the other, though the rigors were suspended, they returned on removing the compression. This happened after several trials ; nor was the pulse ever altered.

H

In

In a case of incipient pyrexia, a tourniquet was applied to an arm and thigh ; the patient almost immediately became vertiginous, and vomited. In another case, a pain of the loins was much aggravated by compression at the iliacs. But such variety of effects, every one acquainted with the animal economy would rather expect than be surprised at.